

Low Emitting Matters

A Product Specification Program Comparator

An essential component of any sustainable building program is ensuring a healthy indoor environment. A key strategy for achieving this goal is to reduce the amount of pollutants such as volatile organic compounds (VOCs) emitted from interior products and building materials.

Most building and design professionals realize the importance of good indoor air quality as part of their responsibility towards their clients and occupants of the spaces they design. Specifying low emitting products is the key to reducing indoor air pollution. The challenge of finding low emitting products is currently being intensified by the challenge to evaluate the standards against which these products have been measured. Emission criteria and standards have been developed to put meaning to chemical emission levels, but many of these standards were not designed for indoor environments or ease of use. Some were never designed for emissions performance evaluation, while others fail to address aspects crucial to determine products as low emitting.

Different Programs, Different Assumptions, Different Results

A number of programs strive to support the overall goal of creating healthier indoor environments by controlling VOC emissions, however these programs are not the same. They are based on very different methodologies and applications.

This “comparator” looks at three programs that address low emitting products for building interiors. The goal is to discern the scientific and practical differences of each to allow design professionals to choose the appropriate program for their specific needs. The featured programs are:

GREEN SEAL™

CALIFORNIA SECTION 01350, Special Environmental Requirements

GREENGUARD Certification Program™

Questions to ask about IAQ Programs

1. Was the product actually tested for chemical emission performance?

To properly determine a product’s effect on indoor air quality, it must be tested for its chemical (and in some cases particle) emissions. Indoor air quality performance can only be determined through environmental chamber testing. Only environmental chamber testing produces credible data by testing the product in realistic conditions with controlled experimental variables.

Many products are labeled as “Formaldehyde free,” “low VOC,” or “IAQ friendly” or “safe” without further qualification. In many cases these claims are based on content, test methodologies not adequate for indoor air, or pure assumptions. There is a common misconception that products that do not contain Volatile Organic Compounds (VOCs) do not release VOCs into the indoor environment. Unfortunately, studies have shown that products can still release chemicals into the air even when they are not a part of the originally manufactured content. The United States Environmental Protection Agency (US EPA), for example, studied paints and coatings and discovered that some of these products generate VOCs, such as formaldehyde, as a by-product during application. Specifically, conversion varnishes reveal the formation of formaldehyde during the curing process. Content analysis would not indicate these types of chemical reactions (Journal of the Air Waste and Management Association, Vol. 49, 1999).

Additionally, most test methods used to measure chemical content in products were developed for outdoor requirements and do not apply to indoor air quality. One such test is the US EPA's Test Method 24. This test does not detect low levels of VOCs; so, upon re-evaluation, it is common to find that a product releases VOC emissions even though Test Method 24 reports "No VOC" content. Even small VOC concentrations can profoundly impact indoor air quality. For this reason, outdoor emissions requirement tests are inadequate for determining appropriate indoor air levels. The only way to truly assess a product's impact on the indoor environment is through testing its performance in regards to the chemical emissions.

2. When was the product tested?

Minor changes in the manufacturing process or the product's composition can have significant impact on a product's emission performance. Often the manufacturer is not aware of changes a supplier may have made to some materials. Large industry studies have shown that manufacturing variability and supply materials have an impact on product emissions. This makes it necessary to require ongoing quality and confirmation tests to ensure products are low emitting on a continuous basis. Manufacturers should be able to produce test reports not older than one year to confirm the IAQ performance of their products. Emissions test results older than one year do not accurately reflect the current state of the product.

3. How was the tested product sample selected?

Most products are available in a multitude of variations or combinations. Wallcovering or textiles, for example, are available in thousands of different patterns, colors, and materials; insulation is available in different densities; office furniture is available in thousands of different combinations regarding fabric, components, cushioning, finishes, substrates, etc. While such a multitude of choices is great for the specifying professional, it often renders indoor air quality based product claims meaningless: unless, the selection of the representative product sample to be tested was done in a scientific and reproducible fashion.

The sample usually represents a larger group of products and product variations, which only works if the selection of the representative sample is actually based on scientific research and some selective testing in order to establish a worst-case scenario. If the worst-case sample meets the emission requirements, all other products in that group most likely will too. Unfortunately, not all indoor air quality product specification programs define a process for sample selection and leave it to the manufacturer to pick a “representative” sample. This usually means that only products, which are most likely to meet the requirements, will be selected as test samples. In some cases manufacturers may be tempted to specially make “custom” low emitting products, if they suspect that none of their mainstream products would pass. In any case, without careful sample selection based on established criteria and a scientific selection process, it is almost impossible to predict the emissions performance of different variations of products based on one sample.

To add a degree of complexity, the period between the time when the product leaves the manufacturing line until the time of testing must be clearly defined. The recommended time period is usually within the first 7 days after manufacturing because many products, for example office furniture, are typically installed and used within that time period. And, it is possible to calculate the future emissions performance of a product, but it is impossible to test an older product and calculate backwards.

4. Is a Chain-of-Custody required?

“Chain-of-custody” is a quality assurance process requiring manufacturers to follow set guidelines for the packaging and shipping of their products to the laboratory that is testing the product. It helps to ensure testing procedures are done in the utmost objective and controlled manner. Unfortunately, not all product certification and specification programs require a chain-of-custody. In other words, a manufacturer could “cherry-pick” products for test submission. Consequently, the product being tested may not be representative of the product being installed in the building.

5. Does the program change the way products are made?

Making a custom out-of-scope product specially designed to meet indoor air quality requirements is one attempt to provide low emitting products. Unfortunately, such custom products are rarely available to the general marketplace and are often priced significantly higher than the “standard” counterparts. The key to manufacturing low emitting products is tight process and quality control, which is extremely hard to do for custom-made products. Therefore, repeat and long-term indoor air quality performance of such products is unlikely. A product’s indoor air quality performance must be an intricate part of the manufacturing and quality control process to ensure ongoing product excellence. Only an indoor air quality program that encourages manufacturers to adopt indoor air quality parameters as part of their standard manufacturing and quality control processes can achieve its objectives in the long run.

6. Is the program product or project focused?

Section 01350 is unique in that it focuses specifically on qualifying products for specific projects. This has certain advantages for large, specialty projects such as the 1.5 million sq. ft. Capital Area East End Complex, for which Section 01350 was originally written, but has many disadvantages for day-to-day designing of building interiors. On a daily basis, most architects and interior designers do not have the time nor the expertise to rework the calculations for each building product and material, furnishing, finishing or office equipment to be used in their building projects, nor is it cost efficient to spend time keeping up with whether a number of products typically used in buildings are in compliance or not.

The other two programs highlighted in this “comparator” – Green Seal and GREENGUARD Certification – are product focused. They were tested using the most conservative modeling parameters, which means their test results apply to any designated use of the product. An architect or interior designer simply consults the program’s listing and is assured the products in question are in compliance by virtue of their appearance on the list. The manufacturer and the certification program do the work. For most design professionals, this is a more cost-effective approach.

7. What chemicals are covered under the program?

Products emit hundreds, sometimes thousands of different chemicals and for an indoor air quality program to be effective, it should test for all VOCs emitted. Unfortunately, some indoor air quality specifications only require testing for a very limited list of chemicals, thereby missing a great number of potentially harmful indoor air pollutants. Some programs actually address fewer than 60 specifically identified VOCs. Currently, only GREENGUARD Certification requires that all products be tested for wide range of volatile organic compounds (over 2,000) and be cross-checked for the presence of VOC carcinogens, reproductive toxins, odorants, and irritants. GREENGUARD Certification tests for each and every volatile chemical found and requires those chemicals known to have a regulated exposure level, must emit no greater than 1/10th the allowable occupational level or be no greater than the EPA ambient pollutant levels.

Additionally, measuring the Total Volatile Organic Compounds (TVOC) emissions of a product is an important indicator of a product’s overall contribution to indoor air pollution and is used by leading IAQ experts around the world. Nevertheless, some indoor air quality programs have no requirement for the TVOC load a product emits. GREENGUARD Certification measures and has an allowable level of TVOC. This is important since it is well documented that mixtures of low levels of VOCs can degrade the perceived IAQ and lead to irritation among building occupants, the most common IAQ complaint. Identification of all individual VOCs also assists in identifying any hazardous individual VOCs that need to be controlled; these can be added as target chemicals and practically limit the measurements that have to be made.

Green Seal

Green Seal is an independent, non-profit organization that identifies and promotes products and services that cause less toxic pollution and waste, conserve resources and habitats, and minimize global warming and ozone depletion. Green Seal uses an open consensus-based process to develop its standards and relies on outside funding to support this process. For an interior building product to achieve certification, the product must meet the Green Seal environmental standard for its category as demonstrated by rigorous evaluation and testing and a plant visit.

Green Seal looks at VOC levels in terms of content and does not test for product emissions performance. The specific VOC content requirements vary with each product category and even among products within each category. *This is a content-based requirement.* VOC content is not the same as VOC emissions and is not an accurate guide for determining whether a product is low emitting or not. These Green Seal standards apply to: Coated Printed Paper (GS-10), Commercial Adhesives (GS-36), Paints (GS-11), Anti-Corrosive Paints (GS-03).

Green Seal standards include:

- Coated Printed Paper (GS-10) –Prohibits the paper’s coating from being formulated with free formaldehyde.
- Commercial Adhesives (GS-36) – Addresses a wide variety of commercial adhesives with each product type having a different VOC content requirement.
- Paints (GS-11) – Specifies two levels of VOC content: one for flat and one for non-flat paint. These VOC content level thresholds are referenced in the LEED™ 2.1 credit for low-emitting paints and coatings. This standard also prohibits a number of VOCs, semi-VOCs and formaldehyde from being used as ingredients to manufacture the paint.
- Anti-Corrosive Paints (GS-03) –Specifies the same level of VOC content for flat, semi-gloss and gloss paint. This standard also prohibits a number of VOCs, semi-VOCs and formaldehyde from being used as ingredients to manufacture the paint.

Indoor air requirements vs. outdoor air requirements

Green Seal air quality requirements are based largely on VOCs that photo chemically react with sunlight to form ozone; hence this requirement is based on outside air use and is not necessarily representative of indoor air environments. Moreover, it does not take into account a number of VOCs that are known to emit from interior products and may cause problems in the indoor environment.

Product Selection Process

Product selection is left to the manufacturer’s discretion. Thus, test results are not representative of future production.

Product Certification

Manufacturers with approved products or services may use the Green Seal logo as a verification that their product complies with published Green Seal standards.

In addition, Green Seal publishes “Choose Green Reports”, which provide overviews of issues relating to product selection as well as lists recommended products. The products listed may or may not have a Green Seal certification or fully comply with Green Seal standards.

Maintaining Certification

After products are evaluated and found in compliance with the applicable Green Seal standard, the manufacturing facility is visited to ensure that the current product is representative of future production. Once certified, *products are subject to annual monitoring.*

California's Special Environmental Requirements Specification Section 01350

California's Special Environmental Requirements Specification Section 01350 (also known as California 1350 or Section 01350) has been developed as a pilot study to screen building materials used in the construction of the 1.5 million sq. ft. Capital Area East End Complex in Sacramento, California. Section 01350 has been adapted for use on other projects and is included in two state-funded publications: Reference for Specifications for Energy and Resource Efficiency (CEC 2001) and the Collaborative for High Performance Schools (CHPS) Best Practices Manual: Materials Specifications (CHPS, 2002) as the criteria for low-emitting materials. The CHPS program is a self-certification system modeled after the structure of the USGBC LEED™ program but is more specific to school construction.

Two points worth noting: Section 01350 does *NOT* carry the force of law nor is it incorporated into any building code or adopted by any state, including California. Also, Section 01350 is project specific, whereas other programs focus on products.

A key element of Section 01350 is its IAQ guidelines, which describe VOC emissions testing of products and materials used in a specific project. The goal is that all products specified for a particular project will be tested. The following summarizes the major provisions.

Realistic Test Specimens.

A realistic test specimen is required for wet-applied materials, which means the product must be applied to the substrate on which it will be applied in the specific project. Individual components for material assemblies (such as floor or wall systems where the finish material is applied over the substrate, either with or without adhesives) are required to be tested separately. If all the components meet Section 01350's requirements, no further testing is needed; however, if one component fails to meet the requirements, the entire assembly must be tested to meet the requirements.

Product Testing

Section 01350 requires manufacturers' products to be conditioned for ten days prior to testing. This is not a realistic approach, because in the vast majority of building or renovation projects, products are not aired out prior to installation or occupancy. This is a surprising requirement given the availability of proven methodologies that allow the modeling of future emission performance after testing a product for a week with minimal conditioning. Additionally, the Section 01350 emission levels are so low that the conditioning environment must be contaminant free to prevent cross-contamination. This makes the Section 01350 process extremely costly because the products have to spend ten extra days in the environmental chamber for conditioning prior to the 96-hour testing.

To determine if a product or material complies with Section 01350 emission requirements, a complex set of calculations must be done using a number of variables, such as the emission rate for each VOC and formaldehyde being emitted (reported in $\mu\text{g}/\text{m}^2$), the surface area on which the product will be installed, the air volume of the

building, and the planned average air exchange rate. The goal is to achieve a more precise calculation of potential VOC levels under the specific indoor environmental condition being considered for each project. The GREENGUARD Certification Program (described below) does similar modeling calculations for the products undergoing testing, but uses set parameters to represent a worse case scenario. To be able to claim that a building fully complies with Section 01350, an architect or designer must repeat the calculation process for each project in which tested products will be used, as the values for the variables in the calculations likely will change from project to project.

Health-based claims

By using California's OEHHA list of Chronic Risk Exposure Levels (RELs) as a basis, Section 01350 attempts to set health-based emission criteria, which is a commendable effort. However, given the lack of conclusive science relating short and long term health risks to indoor chemical exposure levels, claiming that any pseudo-absolute chemical emission level is health-based is questionable at best. Nevertheless, generally lowering the levels of chemical contaminants in the indoor air most likely also lowers the risk of future health effects.

VOC and TVOC Identification and Analysis

Section 01350 presents significantly limited indoor air quality criteria because it bases the determination of low emitting products solely on California's OEHHA list of Chronic Risk Exposure Levels. Many potentially toxic or irritating VOCs are omitted and the total load of pollution is ignored. Products emit hundreds, sometimes thousands of different VOCs and the list of RELs only features 76 chemicals, only 60 of which are actually emitters, meaning VOCs. Among the VOCs not addressed under the Section 01350 program are a large number of toxic and irritating volatile chemicals that are known to emit from interior products, including BHT, Estragole, Phenanthrene, Furan and Cyclohexanone.

TVOC is a measure of the total pollutant load. Section 01350 does not specify what level of TVOC is considered too high and does not test for TVOC.

Product Selection Process

Section 01350 neither requires a chain-of-custody for products being considered for certification, nor does it specify a selection process for representative samples. This means that manufacturers could make a special product to meet the requirements for a specific project rather than improve their standard products. This approach has few advantages for the general marketplace. Section 01350 does not provide a standardized program that addresses product installations, product handling, and test methods.

Product Certification

There is no identifiable product label or mark under the Section 01350 program. To determine if a product or material complies with Section 01350 emission requirements, a complex set of calculations must be done using a number of variables, such as the emission rate for each VOC and formaldehyde being emitted (reported in $\mu\text{g}/\text{m}^2$), the surface area on which the product will be installed, the air volume of the

building, and the planned average air exchange rate. The goal is to achieve a more precise calculation of potential VOC levels under the specific indoor environmental condition being considered for each project. GREENGUARD Certification does similar modeling calculations for the products undergoing testing, but uses set parameters to represent a worse case scenario. To be able to claim that a building fully complies with Section 01350, an architect or designer must repeat the calculation process for each project in which tested products will be used, as the values for the variables in the calculations likely will change from project to project. The Section 01350 calculation process adds costs to the project and may require hiring of a consultant to perform the calculations.

Nevertheless, efforts are under way to compile a list of products meeting Section 01350 requirements under a given set of parameters. Unfortunately, this list will be meaningless without stringent product selection and chain-of-custody requirements, as well as regular intervals for product retesting.

Maintaining Qualification

There is no specified requirement for maintaining qualification or regular monitoring of product performance under the Section 01350 program.

Bottom Line

Section 01350 is a commendable attempt to address the growing concerns about indoor air pollution in an innovative, more building oriented fashion, and it provides valuable perspectives on source control and indoor air quality. However, Section 01350 has surely not outgrown its testing stage and is not ready to be released into the wider market.

GREENGUARD Certification Program

Since 2001, the GREENGUARD Environmental Institute (GEI) has established performance-based, field-validated standards to define products with low chemical and particle emissions for use indoors, primarily building materials, interior furnishings, furniture, cleaning and maintenance products, electronic equipment and personal care products. The standards establish certification procedures, including test methods, allowable emissions levels, product sample collection and handling, testing type and frequency, and program application processes and acceptance. More than 80 percent of products attempting certification require changes in their product formulas and manufacturing processes before they are able to meet the stringent emissions requirements.

Product Testing

GREENGUARD Certification requires emission performance testing. The maximum allowable emission levels are those required by the State of Washington's Indoor Air Quality program for new construction, the EPA's procurement specifications, the recommendations from the World Health Organization, and Germany's Blue Angel Program for electronic equipment. When multiple emission values are recommended, the lesser or more stringent is used as the acceptable emission value for GREENGUARD Certification.

VOC and TVOC Identification and Analysis

GREENGUARD Certification requires testing for over 2,000 individual VOCs. All individual VOCs detected must meet the criteria of less than 1/10 of the threshold limit values (TLVs) established by the American Conference of Government Industrial Hygienists. In addition, the manufacturer is made aware of any chemical detected at any level that is on the International Agency on Research of Cancer, National Toxicology Program, Cal Prop 65 or all three regulatory lists. To calculate TVOC levels, the GREENGUARD Certification Program adds up all the individual VOCs found during the environmental chamber testing.

Rather than using a single data point to determine predicted air concentrations, a statistical analysis of a series of data points collected during the testing period is used. Emission rates of formaldehyde, total aldehydes and TVOC are used in a computer exposure model to determine potential air concentrations of these pollutants. The computer model uses the measured emission rate changes over the one-week time period to determine the change in air concentrations that would occur.

Ventilation and occupancy parameters are those provided in ANSI/ASHRAE Standard 62-2001, *Ventilation for Acceptable Indoor Air Quality*. Conservative modeling parameters are used for air change rates and product loadings to ensure that predicted exposure concentrations are not underestimated.

Maintaining Certification

The GREENGUARD Certification Program is standardized and well defined, including test protocols, controlled sample handling procedures, and on-going quality control testing

to deliver realistic and reproducible results. Once a product line has been certified, it may carry the GREENGUARD Indoor Air Quality Certified® mark and be listed in the GREENGUARD Product Guide. The GREENGUARD Certification Program requires annual re-certification. Products also must undergo quarterly testing to ensure they maintain their compliance with GREENGUARD Certification emission standards.

Product Selection Process

Only the GREENGUARD Certification Program has a strict chain of custody procedure, including providing manufacturers with written instructions, a form to track date of manufacture and shipping date. It also requires the product to be tested within 10-days of manufacture. GREENGUARD certification requires both quarterly monitoring tests and annual certification testing.

GREENGUARD Certification requires that all formulations and configurations of a product be tested before certification. A profile study identifies those materials and processes that primarily affect emissions so that certification categories can be established for representative testing.

All products are tested within 10 days of manufacture (when product emissions are strongest) in dynamic environmental chambers. A product must meet the proscribed GREENGUARD emission levels within the weeklong testing period. If the product meets these requirements, there is no need to “air out” the product before use, which is a major advantage as a certified product can be used “off-the-shelf” in all situations, both in new construction and in renovation projects without additional complicated calculations or modeling of indoor air VOC concentrations.

Standard “off-the-shelf” Products

The GREENGUARD program does not encourage specially made low emitting products that have to be custom ordered. GREENGUARD Certified Products are part of the manufacturers standard product offering and can be purchased in small quantities without additional cost.

Indoor Air Quality

The GREENGUARD Certification Program is an indoor air quality program and does not base its requirements on outdoor air criteria. Setting acceptable levels of individual VOC emissions levels is needed because different compounds affect people differently. The GREENGUARD Environmental Institute (GEI) uses this analysis to assist manufacturers achieve lower overall emissions and create products with less potential health impacts, by looking at what chemicals are present at what levels and where in the product formulation, manufacturing or both can this chemical be reduced or eliminated. Further, GEI strives to help manufacturers to adopt a corporate philosophy of creating low-emitting products overall and not just as needed for specific projects. The GREENGUARD Certification program encourages manufacturers to make low emitting products their mainstream way of doing business.